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GEOLOGY OF NORTHWEST BELCONNEN, A.C.T.

by

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1. Geological map of northwest Belconnen
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FIGURE

1. Locality map

SUMMARY

The gently undulating to hilly northwest Belconnen area is underlain by sedimentary, acid volcanic, and intrusive rocks of the Middle and Upper Silurian succession of the Canberra Graben. The succession is probably incomplete, owing to faults. The Deakin Fault, which is a major structural feature of the Canberra region, crosses the centre of the area. Some of the rocks are folded, but data on folding are limited by the massive nature of many of the volcanic rocks. The intrusive rocks fall into two categories: one rock type, an adamellite, is definitely transgressive; two other formations, however, closely resemble the volcanic rocks and are interpreted as high-level sills.

Engineering geological factors in urban development include ease of excavation, foundation characteristics, geological materials, and drainage. Depths of easy excavation by mechanical means are variable, and are related to the geomorphology and depths of weathering of the underlying rock types. Depths to firm foundations for large structures are also variable, but foundation conditions are expected to be good in most places; difficulties may be experienced along fault zones and in a small area where cavernous limestone is suspected. Road gravel deposits are the only geological materials of economic importance in the area. Some of the igneous rocks would be suitable for crushed rock aggregate; however, the locations of all materials within the urban area would make exploitation undesirable on environmental grounds. The area is well drained, except for a few seepages and small swampy areas.

INTRODUCTION

The area described in this report covers about 19 km^2 in the Belconnen District, northwest of Canberra City (Fig. 1). It was mapped in 1966-9 as part of a program designed to extend knowledge of the local geology, and to provide geological information for the proposed urban development of the area. Observations were plotted on six map sheets, scale 1:2400, obtained from the Lands and Survey Branch of the former Department of the Interior. The areas covered by each of the six sheets are shown by the index in Plate 1. Sheet areas G4A and G4B were mapped by C. Mitchell, L. Gerdes, and L. Walraven during 1966; sheet areas G3D, H3C, and H4A by vacation students, G. Holt and N. Christiansen, in January 1968; and sheet area G3C by G.A.M. Henderson in February 1969. The trench for the Belconnen trunk sewer, crossing sheet areas G4A, G4B and H4A, was mapped by G.A.M. Henderson. Since 1969, urban development of much of the area has been carried out to form the surburbs of Latham, Macgregor, Charnwood, Flynn, Melba, Evatt, Spence, and Fraser. Excavations in a few areas of particular geological interest were mapped during development. Thin sections (Appendix 2) were described by C. May and the Australian Mineral Development Laboratories (AMDEL), and the chemical analyses (Appendix 3) were done by AMDEL. Coordinates shown in Plate 1 and given in appendices are in feet from a datum on Mount Stromlo.

PHYSIOGRAPHY

Apart from two prominent hills, Rogers Hill (706 m) and Goodwin Hill (613 m) (Plate 1) the area is moderately to gently undulating; the lowest part of the area, the western valley of Ginninderra Creek, is about 543 m a.s.l. Goodwin Hill is elongated in a north-west direction and is formed by a resistant rhyolite bed. The ridge crossed by the former Glebe Road immediately to the south of Ginninderra Creek, is aligned with the direction of the hard quartz reefs of the Deakin Fault that crop out along it. The Deakin Fault also passes through Charnwood Hill, in the north of the area, where a quartz reef was mapped.

Ginninderra Creek is the main watercourse, and flows from east to west across the southern part of the area. It is entrenched about 8 to 15 m in the surrounding countryside. Where it cuts through the resistant rhyolite to the southeast of Goodwin Hill, the valley sides are steeper and the gradient of the creek increases. Narrow alluvial flats border the creek along much of its length; in some places there are alluvial terraces about 1.5 m above the present flood plain. Along some of its length the creek flows northwest along the strike of the underlying bedrock; however, a sharp swing to the southeast, also parallel to the strike, takes place at the eastern edge of the rhyolite (Sud_3). Tributary creeks also tend to follow the strike of the bedrock; the creek in the eastern half of the map area flows southwest across Glebe Road along the boundary between the dacite (Smp) and the Glenesk Formation (Smg).

Rock outcrops are abundant on the hills and on the steeper slopes along Ginninderra Creek. Much of the gently undulating terrain is devoid of outcrop, and elsewhere outcrops are widely scattered.

STRATIGRAPHY

The rocks in the area range in age from Middle to Upper Silurian, and belong to formations which crop out extensively in the Canberra Graben (Strusz, 1971). Most of the volcanic rocks are shown as Deakin Volcanics on the Canberra 1:50 000 geological map (Strusz & Henderson, 1971), but recent mapping outside the area indicates that correlations with other named formations are more appropriate. One formation of rhyodacite (Suu) does not appear to correlate with any named formation.

MIDDLE SILURIAN

Westmead Park Formation? (Smw)

Four outcrops of siltstone and silty mudstone comprise the only sedimentary rocks mapped in the area northeast of the Deakin Fault. The outcrops all occur in a watercourse which flows southwest into Ginninderra Creek and which roughly follows the former Glebe Road. Two of the outcrops are immediately north of the cross section line AB; the southernmost one of the two shows an irregular contact with weathered dacite, probably Smp_2. Another is in the creek downstream from Glebe Road, and it also shows an irregular contact with weathered dacite. The rock at these three localities is silty mudstone with no recognizable bedding.

The fourth outcrop is a little less than 1 km downstream from the third outcrop, and consists of siltstone and silty mudstone containing the brachiopod *Lingula*. The dip is about 30° to the northwest and the outcrop is along strike from the other three exposures. This observation, and the fact that all four exposures are near the contact of the overlying volcanics of the Glenesk Formation, indicate that the siltstone and mudstone outcrops, although discontinuous, are at the same stratigraphic level as one another.

The siltstone and mudstone are tentatively correlated with the Middle Silurian Westmead Park Formation (Smith, 1964) because similar rocks apparently belonging to that formation have been found immediately beneath the dacite and quartz andesite of the Glenesk Formation in the Gooromon Ponds area (Henderson, 1975b). The brachiopod, Lingula, neither confirms nor disproves the correlation; it is a long-ranging genus found in rocks ranging from Cambrian to Recent.

Glenesk Formation (Smg)

Dacite and quartz andesite of the Glenesk Formation occupy the slopes around Rogers Hill and are bounded by the Deakin Fault to the southwest; the southeast margin follows the gully near the former Glebe Road. A small area of volcanics, possibly Glenesk Formation, was also mapped to the south of Ginninderra Creek and immediately southwest of the Deakin Fault (cross-section CD). The rocks of the formation extend far beyond the northern margin of the map; the type area is north of Spring Range, about 17 km to the north*.

The rocks of the Glenesk Formation in the area mapped are most commonly green-grey or purple quartz andesite; in a few places dacite crops out. Although outcrops are numerous it is impossible to subdivide the formation because of the massive nature of the rock and the lack of persistent and recognizable marker horizons. Exposures of medium-grained tuff in a trench near the intersection of Charnwood and Glebe Roads, and a black tuffaceous slate on the northern slopes of Rogers Hill (Saltet, 1972) probably represent lenses within the massive volcanic flows.

A typical thin section of the volcanics is described in Appendix 2 (thin section 69360117) as a rhyodacite, but a chemical analysis of a similar specimen from another locality which is given in Appendix 3 shows that the silica content is too low for rhyodacite, and that quartz andesite would be a more accurate name (analysis 75360014). The main distinguishing features of the quartz andesite in hand specimen are the sparse phenocrysts and the small amount of quartz. The low quartz content is reflected in the chemical analysis by a lower silica content than in the other igneous rocks analysed.

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* Smith (1964) named the Glenesk Formation the "Glenesk Volcanics", but it was changed to the Glenesk Formation and extended to include rocks to the west of Smith's area for the 1964 edition of the Canberra 1:250 000 geological map (Strusz, 1970). Both Smith and the 1:250 000 geological map showed the formation as Upper Silurian (Sug). Fossil evidence from the literature for the position of the boundary between Middle and Upper Silurian rocks is conflicting (Öpik, 1958; Link, 1970), but a Middle Silurian age for the formation is more likely.

The thin sections and chemical analysis indicate correlations between the Glenesk Formation and two named formations in the Canberra area: the Middle Silurian Gladefield Volcanics (Moore, 1957) and the Ainslie Volcanics (Opik, 1958). The latter correlation raises the possibility that the Glenesk Formation is Early Devonian, in accord with Opik's interpretation of the age of the Ainslie Volcanics. However, structural limitations for the age of the Glenesk Formation in the area mapped are evident. These limitations are the Middle Silurian age of the Westmead Park Formation, which it overlies, and the earliest Late Silurian age of the inferred Yass Group, which is downfaulted against it immediately southeast of the Deakin Fault. It is likely therefore that the age of the Glenesk Formation is late Middle Silurian.

The thickness of the Glenesk Formation in the mapped area is not known. Even a minimum estimate is difficult to determine because of the lack of structural information. A considerable part of the formation has probably been cut out by movement on the Deakin Fault, which is known to have a large displacement.

The possible occurrence of the Glenesk Formation in the two fault slices immediately southwest of the Deakin Fault is inferred from a thin section of quartz andesite (thin section 72360050) from the northeast fault slice; the location of the outcrop is about 1 km south of the southern margin of the map (Plate 1). This rock is the same as the quartz andesite of the Glenesk Formation northeast of the fault. Rock outcrops in the fault slices on the map are strongly sheared and silicified; the rock was similarly affected where it was exposed in the trunk sewer trench.

UPPER SILURIAN

Yass Subgroup (Sdy)

Siltstone and impure limestone were mapped in the trunk sewer trench southwest of, and close to, the Deakin Fault near the southern margin of the map and are tentatively assigned to the Yass Subgroup (Cramsie, Pogson, & Baker, 1975). The limestone was found in the northeastern part of the section and was separated from the siltstone by about 50 m with no rock exposure. A thin section of the siltstone is described in Appendix 2 (thin section 67360033). Fossiliferous tuffaceous sandstone has also been mapped a short distance south of the map area (Yendall, Walraven, & Doutch, 1967).

The limestone is fossiliferous, containing corals and trilobites, and was previously considered as a possible correlate of the Yarralumla Formation (Henderson, 1970; Strusz & Henderson, 1971). The tentative correlation with the Yass Subgroup in this report is based on a match between the sequence of sedimentary and volcanic rocks at northwest Belconnen and the sequence in the Gooromon Ponds area (Henderson, 1975b), where the sedimentary rocks at the bottom of the sequence are regarded as a southern continuation of the Yass Subgroup (D.L. Strusz, B.M.R., pers. comm.). If Öpik's (1958) correlation of the Yarralumla Formation with the Barrandella Shale Member at Yass, which is somewhat younger than the Yass Subgroup, is correct, correlation of the siltstone and limestone at Belconnen with the Yarralumla Formation would not be valid.

Unnamed Volcanics (Suu)

The rhyodacite which overlies the probable Yass Group in the Belconnen area could be correlated with several formations on the basis of either stratigraphic position or similar lithology, but nowhere is there a firm correlation on both counts. It has therefore been left unnamed for the present.

The rhyodacite crops out in two broad bands: one in the centre of the area; the other in the southwest corner. The formation probably comprises several flows of similar composition. The lowermost part was mapped in the trunk sewer trench immediately southwest of the siltstone and limestone (Sdy). The rock is green-grey and is distinguished in thin section from the rhyodacite higher in the formation by the plagioclase, which is less calcic, and by a lack of orthoclase phenocrysts; thin section 67360032 (Plate 1) is representative. The middle and upper parts of the formation are generally purple, and one flow is well banded. Phenocrysts tend to be sparser than in the lower parts and minor pink feldspar is evident in some places; the plagioclase is generally labradorite. Three thin sections (numbers 69360086, 69360087, and 66360039) are described in Appendix 2 and a chemical analysis (number 75360018) is given in Appendix 3.

The topmost part of the formation is not well known; some of it may have been removed by the north-northwest-trending fault through Latham and Charnwood. The total thickness of volcanics is difficult to estimate because of the folding and faulting, but exceeds 300 m.

A bed of tuffaceous siltstone in the rhyodacite was mapped in the trunk sewer trench near the boundary of Latham and Macgregor immediately west of the northwest-trending fault through Macgregor. The rock is white and contains a few lenses of coarse purple tuff.

Deakin Volcanics? (Sud)

Rhyolite, tuff, and sedimentary rocks which are possibly Deakin Volcanics (Öpik, 1958) were mapped at Latham and Macregor. The basis of correlation with the Deakin Volcanics is the rhyolite, which is also found in the type area of the volcanics. However, the structural separation from the type area of the Deakin Volcanics makes the correlation difficult to verify; also, structural and stratigraphic evidence from outside the map area can be used to argue against such a correlation.

Three units were mapped in the volcanics. The lowermost unit, Sud_1, consists of banded purple tuff, green and grey lapilli tuff and ashstone, red siltstone, and laminated brown tuffaceous siltstone. The rocks were mapped along a meridional band in the central part of Latham, where they are downfaulted against the rhyodacite Suu. A section across the sequence was mapped in the trunk sewer, where medium-grained banded purple tuff (thin section 67360026, Appendix 2) was overlain at the western end by about 3 m of laminated tuffaceous siltstone (thin section 67360027, Appendix 2). The lapilli tuff and ashstone were mapped in two places: one in Ginninderra Creek, where it was interbedded with the red siltstone; and the other in excavations near the southern margin of the map. The total thickness of unit Sud_1 is not known, as the north-northwest-trending fault through Latham and Charnwood has removed the basal part of the sequence from the eastern side; a minimum thickness of about 140 m is inferred from exposures in the trunk sewer trench.

Sud_2 is pink and purple rhyolite which overlies Sud_1 in central and northern Latham; the contact with Sud_1 was observed in the trunk sewer trench. The rhyolite is about 150 m thick and shows a gradual coarsening of texture from the bottom to the top of the flow. The petrology is described in Appendix 2 (thin section 69360114); a chemical analysis is also given in Appendix 3 (analysis number 75360017).

Sud_3, like Sud_2, is also pink and purple rhyolite, but differences in composition and texture between the two units enable their separation. Sud_3 crops out along a northwest-trending belt extending from Latham to the northwest corner of the map area, and dips to the southwest. The rock is generally more acid than Sud_2, containing little or no plagioclase; it also contains fewer phenocrysts. Mafic minerals are present in some places but absent in others. Some of the rock is a rhyolitic breccia. Thin section 69360081 (Appendix 2) is typical of the unit. The total thickness of Sud_3 is not known, as both its upper and lower contacts are faulted; a minimum thickness of about 340 m is estimated.

INTRUSIVES

Unnamed Porphyry (Smp)

Dacite which crops out in the eastern part of the area was regarded by Wilson (1961) as intrusive and mapped as Mount Painter Porphyry (Öpik, 1958). On the other hand Yendall et al. (1967) regarded the southern continuation of the unit in the Lake Ginninderra area as extrusive. Since 1967 additional information has been derived from excavations for the Lake Ginninderra dam, which is about 300 m south of the southern edge of the map. Intrusive contacts with Upper Ordovician Acton Shale were observed in several places on the eastern abutments of the dam site. Intrusive relations are also indicated at a locality a short distance north of cross section line AB, where contacts of weathered dacite in structural discordance with shale were observed. No evidence, such as flow banding or conformably interbedded tuffs, was found to indicate an extrusive origin for the rock.

Textural variations have enabled the dacite to be divided into two units: Smp_1 and Smp_2. Smp_1 crops out mainly north of cross-section line AB. In thin section (number 72360037, Appendix 2) it contains moderately abundant phenocrysts of quartz, plagioclase, and altered mafic minerals in a holocrystalline groundmass; calcite is present as an accessory. A chemical analysis of the rock is given in Appendix 3 (analysis number 75360015). In hand specimen the rock is distinguished by the prominent milky white plagioclase crystals. Smp_2 is very similar in texture to the Mount Painter Porphyry in the areas mapped by Öpik (1958), although the bulk composition probably resembles that of Smp_1. Smp_2 contains abundant phenocrysts in a cryptocrystalline groundmass, and crops out immediately northeast of the Deakin Fault; a thin section (number 69360116) is described in Appendix 2. The boundary between Smp_1 and Smp_2 is uncertain, and Smp_2 may be more extensive than shown on the map.

A typical chemical analysis of the Mount Painter Porphyry from near Scrivener Dam (Appendix 3, analysis number 75360001) has a similar composition to that of Smp_1. Öpik interpreted the Mount Painter Porphyry as a sill, an interpretation which is also possible for Smp; however, the ages of the rocks that appear to form the roofs of the two sills differ. The Mount Painter Porphyry is associated with the Upper Silurian Deakin Volcanics and Yarralumla Formation, whereas the roof of Smp in the map area appears to be associated with Middle Silurian formations, and it seems possible that the Mount Painter Porphyry and Smp are structurally separate.

Willow Bridge Tuff (Suw)

Rhyodacite whose northern continuation corresponds to the Willow Bridge Tuff at Yass crops out along a northwest-trending belt in the western part of the map area. The connection with the Willow Bridge Tuff has been established by mapping in the Gooromon Ponds area (Henderson, 1975b) and further to the north-northwest (M. Owen, B.M.R. pers. comm.). The rhyodacite is distinctive both in hand specimen and thin section. Field relations in the map area appear to confirm an intrusive origin in some places, and an extrusive origin at others; the evidence is inconclusive at this stage.

The distinctive features of the rock are the pale to dark grey colour, as distinct from the green-grey or purple of the crystalline volcanic rocks and the unnamed porphyry Smp. In thin section the paler specimens have an extremely fine-grained, but holocrystalline groundmass, and biotite phenocrysts which are unaltered, or only partly altered, to chlorite and other secondary minerals. The phenocrysts, which also include quartz, plagioclase (labradorite), and in some places orthoclase, are generally more abundant than in the volcanic rocks previously discussed; the groundmass is cryptocrystalline and shows a flow texture. Thin section 69360080 (Appendix 2) is typical of the paler grey rock. A chemical analysis of a sample from a locality on the Brindabella 1:100 000 sheet is given in Appendix 3 (analysis number 75360008).

The petrology suggests that the rock is a welded tuff; however, its apparent structural relation to the surrounding volcanic rocks in the area, and the observed intrusive contacts of a rock of similar composition and textural features with sedimentary rocks on Mount Stromlo (Henderson, 1975a), indicate that the rock may not be extrusive. The positions of the contacts with the surrounding rocks in the map area, when related to the topography, indicate that the Willow Bridge Tuff is a sheet-like rhyodacite body underlain by the unnamed volcanics Suu and the rhyolite Sud_2, and overlain by the rhyolite Sud_3; the rhyodacite appears to form a wedge between the two rhyolites at its southern end, with the apex of the wedge near the southern margin of the map. As it does not seem likely that a rhyodacite of such clearly different characteristics from the two rhyolites would interrupt the rhyolite flows as a volcanic flow itself, the rhyodacite might be a sill similar in form to the Mount Painter Porphyry, or the apparent sequence of the volcanics may be structurally controlled with the rhyolite Sud_3 thrust over the rhyodacite into its present position. The latter interpretation is favoured because it is in accord with the relations in the Gooromon Ponds area, where the rhyodacite (Suw) is everywhere above the rhyolite, and appears to be unconformable on it and older rocks (Plate 2).

Contacts between the rhyodacite and the rhyolites were exposed by excavations, but in most places the rock was too weathered to enable the attitude or the nature of the contact to be observed clearly. However, a contact with the rhyolite Sud_2

was observed about 100 m north of Ginninderra Creek; the contact was not sharp, but showed a gradual change from one rock type to the other over a distance of several metres. The rhyodacite near the contact was very dark grey and contained pink feldspar. No sign of bedded tuffs or sedimentary rocks was seen in the contact zone.

A few outcrops of rhyodacite similar to the Willow Bridge Tuff crop out along Ginninderra Creek on the southern edge of Flynn. The similarity is particularly evident in thin section 66360000, which contains unaltered biotite and a groundmass similar to that in thin section 69360080 (Appendix 2). The rock body is about 750 m long and 100 m wide on the surface and is apparently a dyke or sill within the unnamed volcanics Suu.

A definite conclusion on the origin of the Willow Bridge Tuff in the area mapped must await further evidence - probably from outside the area - to clarify its relations with other formations.

Glebe Farm Adamellite (amg)

The Glebe Farm Adamellite (Strusz & Henderson, 1971) crops out in two bands northeast of the Deakin Fault. The rock is porphyritic and coloured pale grey, green, or pink; distinctive features are the pale colour and large phenocrysts. The groundmass of the rock (see thin section 67360035, Appendix 2) is also much coarser-grained than in any of the volcanic rocks or the porphyries Smp and Suw. The linear distribution of the adamellite outcrops indicates structural control of the two intrusions.

STRUCTURE

FAULTING

The dominant structural feature in the area is a fault of large displacement, the Deakin Fault, which strikes northwest across the centre of the area. The fault is normal with the downthrow on the southwestern side, and is a continuation of the Deakin Fault mapped by Öpik (1958) in the Canberra City area. The fault splits into three parallel faults where it crosses Ginninderra Creek; the three faults were exposed in the trunk sewer trench and were seen to be steeply dipping. Quartz reefs are present in places along the fault line.

Two of the three northwest-trending faults southwest of the Deakin Fault also have large displacements: one crosses Macgregor west of Goodwin Hill, and the other crosses Charnwood and the eastern part of Latham. The structural block between these two faults is downthrown. Both the faults are shown as steeply dipping reverse faults on the cross sections (Plate 2); however the evidence, which is based on the relations between the fault lines and topography, is inconclusive. The faults are indicated on the surface by strong shearing in adjacent outcrops and also by lithological and structural discontinuities.

Two faults of relatively small displacement were mapped immediately southwest of the three parallel faults forming the Deakin Fault at Ginninderra Creek. One of them is a moderate-angle (about 45^{o}) westerly dipping normal fault which forms the western boundary of the inferred Yass Subgroup (Sdy); the fault was clearly exposed in the trunk sewer trench. The other fault strikes northeast and is indicated by shearing of outcrops in Ginninderra Creek.

A possible low-angle thrust fault is inferred on the southwestern boundary of the Willow Bridge Tuff. Such a fault is regarded as the most likely explanation for the outcrop pattern consistent with the inferred unconformity between the tuff (Suw) and the apparently older units - namely Suu, Sud_1, Sud_2, and Sud_3.

FOLDING

Folding of the rocks in the area is indicated in some places from measurements of attitudes of bedding and flow banding. A syncline trending north-northwest was mapped in flow-banded rhyodacite (Suu) at the western edge of the map area. Folding of the same rhyodacite in the Flynn area is evident along Ginninderra Creek and to the north, and is based on the attitudes of flow banding. An apparent repetition of the rhyodacite flow can be explained by an anticline and syncline trending west-northwest as shown in Plate 1. A variation in the dip of the limestone in thr trunk sewer trench (Sdy) indicates that the rock is folded, but no anticline or syncline was observed.

The Deakin Volcanics and Willow Bridge Tuff are tilted to the southwest, but do not appear to be appreciably folded. Folding is not evident in the Glenesk Formation (Smg) because of the massive nature of the rocks; the boundary with the Westmead Park Formation appears to trend northeast and in one place the dip of shale at the contact is 30^{o} to the northwest.

ENGINEERING GEOLOGY

EXCAVATIONS

Trenches for reticulation services in Latham and to the south of the area mapped have enabled observations of soil and depths to bedrock. In particular, observations along the Belconnen trunk sewer excavations have enabled comparisons of the weathering characteristics of most of the rock types in the area.

In general the depth of soil is related to the nature of the bedrock and the geomorphological history of the area. Thin soil is found on steep slopes where erosion is most active; outcrops tend to be more numerous in these areas. Steep slopes commonly occur where the underlying bedrock is resistant to weathering, such as in the areas underlain by the rhyolite Sud_3 and the Glenesk Formation (Smg). Thicker soil is found in gently undulating areas where outcrops are sparse or absent. Thick soil is also found locally at the base of steep slopes where colluvial deposits have accumulated and where there are outwash fan deposits.

Some of the rock types, particularly the rhyodacite Suw, are deeply weathered along joints, which results in large buried boulders of fresh rock surrounded by highly or extremely weathered rock. Soil depths are variable where boulders occur. Other rock types, such as the purple rhyodacite Suu, tend to weather more uniformly as observed in the trunk sewer trench.

Trenches in the gently undulating area can in most places be excavated, without blasting, to a depth of 2 m. Only on moderate to steep slopes and where outcrops are numerous would extensive blasting be needed at shallower depths. Experience from the trunk sewer trench indicates that the purple rhyodacite Suu in the gently undulating areas is generally the most deeply weathered (3-6 m to moderately weathered rock), whereas the shallowest depth of weathering occurs in the rhyolite Sud_3 (1-2 m to moderately weathered rock). In the other rock types the depths of weathering range between these two extremes. In most places soil grades down into highly or moderately weathered bedrock which in turn overlies fresh or slightly weathered rock.

FOUNDATIONS

The weathering characteristics also affect foundation conditions. In general, small structures which do not impose heavy loadings can be founded on soil. Experience from areas of volcanic rocks elsewhere in the Canberra area indicates that the overlying soil is not sufficiently expansive on hydration to cause serious problems. Multistorey buildings and other large engineering structures would need to be founded on slightly or moderately weathered rock. The bedrock in the area, where fresh, is strong enough to support engineering structures with very high foundation loadings. Observations along the trunk sewer trench indicate that rock of sufficient strength for the foundations of most large buildings would generally be found at depths between 3 and 6 m. However, there are areas with deeper weathering along faults and shear zones, and detailed site investigation is necessary for all major structures in close proximity to major fault zones such as the Deakin Fault. Difficulties with buried boulders might occur in places, particularly in the areas underlain by the grey rhyodacite (Suw) and the adamellite. The limestone of the Yass Subgroup may possibly be cavernous in places; however, no signs of solution cavities were evident where it was exposed over a 30 m section of the trunk sewer trench.

MATERIALS

Small deposits of sand and gravel occur along Ginninderra Creek, but are too small for commercial exploitation. Most of the massive volcanic and intrusive rocks would be suitable, where fresh, for crushing for road and concrete aggregate, or for facing stone; however, their exploitation so close to urban development would provide environmental problems. Weathered rock for road gravel occurs in the area, but other deposits are known at more satisfactory locations.

DRAINAGE

The sloping terrain ensures that most of the area is well drained. However a few small patches tend to be poorly drained; patches greater than 400 m^2 in area are shown on the map as "swampy areas". They are waterlogged during wet weather and tend to remain wet for some weeks after. Only during the summer and long periods of drought do they dry up completely.

Three types of water seepage can be distinguished in the Canberra area (Van Dijk, 1965); two of them were noted in the area mapped: one is superficial hillslope seepage in the more permeable A horizon of the soil, and the other is seepage caused by a high potentiometric surface.

Superficial hillsope seepage occurs in colluvium and in alluvial fans which consist of roughly layered soil with sandy and gravelly horizons. In the area mapped they are mostly confined to the slopes bordering Ginninderra Creek. Along the northern side of the creek at Macgregor extensive deposits of colluvial soil, in which seepage is likely to occur, were found along the lower slopes of Goodwin Hill. Some fan deposits along the creek were also noted to the south of Evatt.

Seepages attributable to a high potentiometric surface are to be found in several places in the area. Two notable examples occur between Flynn and Latham and are shown on the map as swampy areas: in one, an outcrop (grid ref. E8400, N38600) of purple rhyodacite of low permeability restricts the lateral flow of water, which then rises to the surface; and the other is on a flat on the south side of Ginninderra Creek (grid ref. E7200, N38200), where the highly potentiometric surface may be attributed to low permeability in the fault zone immediately to the west.

In wet weather the ground becomes saturated, and boggy patches on gently sloping terrain become common, particularly close to watercourses. This may cause delay and inconvenience during trenching in wet weather. It is expected, however, that stormwater drains in the areas will alleviate most potentially boggy areas.

Several bores in the area have provided water for farm use in the past. The groundwater is derived from fractured-rock aquifers. Bore water could possibly provide an alternative supply for watering lawns in parks and recreation areas.

CONCLUSIONS

1. Northwest Belconnen is gently undulating to hilly, and Ginninderra Creek, the main watercourse, is partly entrenched in the area.

2. The rocks in the area are Middle to Upper Silurian acid volcanics, sills, adamellite, and minor sedimentary rocks. Faulting has disrupted the succession, and the rocks are gently folded.

3. Several faults cross the area, including a large regional fault, the Deakin Fault.

4. Depths of easy mechanical excavation are variable. In some places hard rock close to the surface will require blasting to excavate it.

5. Although soil depths are variable, foundation conditions are expected to be good in most places. However, thorough testing of subsurface conditions for the foundations of large structures should be carried out, particularly in places where cavernous limestone or deeply weathered fault zone material are to be expected.

6. Some construction materials are present in the area, but environmental considerations may preclude their use.

7. The area is well drained, except for a few seepages and wet areas which might cause local drainage and excavation difficulties.

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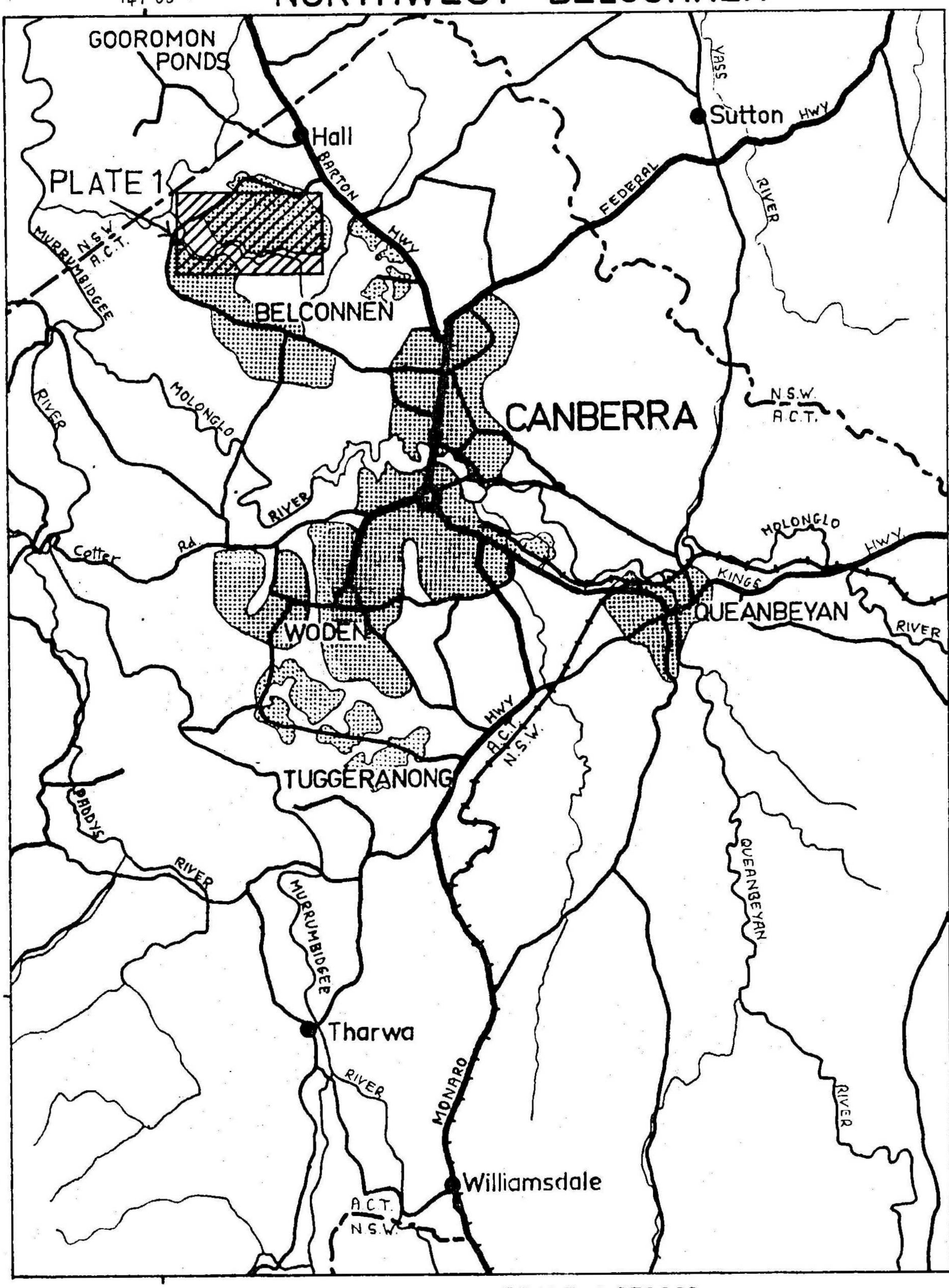
APPENDIX 1

DEGREES OF ROCK WEATHERING

FRESH	: No discolouration or loss in strength.
FRESH-STAINED	: Limonitic staining along fractures; rock otherwise fresh and shows no loss of strength.
SLIGHTLY WEATHERED	: Rock is slightly discoloured, but not noticeably lower in strength than the fresh rock.
MODERATELY WEATHERED	: Rock is discoloured and noticeably weakened; N-size drill core (54 mm) generally cannot be broken by hand across the rock fabric.
HIGHLY WEATHERED	: Rock is discoloured and weakened; N-size (54 mm) drill can generally be broken by hand across the rock fabric.
EXTREMELY WEATHERED	: Rock is decomposed to soil, but the original rock fabric is mostly preserved.

FIGURE 1

LOCATION MAP
NORTHWEST BELCONNEN



SCALE 1:250,000

5 0 5 10 Km.

Built-up area
Highway
Secondary road
Railway
Territorial boundary
AREA OF REPORT

Record 1975/113

I55/A16/1423

APPENDIX 2

PETROGRAPHY

Average mineral percentages of igneous rock units

The mineral percentages shown below are averages of the percentages estimates from thin sections cut from each of the rock units in the area.

Rock	Symbol	Quartz	Plag.	Plag. Comp.	Orthocl.	Mafic	Groundmass[3]
Adamellite[1]	amg	35-40	25-30	An_{55-62}	30-35	5-10	-
Rhyodacite	Suw	30	20-25	An_{57-60}	0-5	10	30-40
Dacite[2]	Smp_2	20-25	20-25	An_{60}	0	15-20	30-35
Dacite	Smp_1	20	20	An_{35-66}	0	10	50
Rhyolite	Sud_3	25	0-5	-	10	0-10	55
Rhyolite	Sud_2	30	10	An_{32-44}	15	1	45
Rhyodacite	Suu	10-20	20	An_{33-59}	0	10	50-60
Dacite[2], quartz andesite	Smg	5-10	15-20	An_{32-62}	0-5	5	60-70

Notes

1. The minerals in the groundmass are included in the percentages of the respective minerals for the adamellite.

2. These rocks are listed as rhyodacites in the thin section descriptions. However, the lower silica content compared with the other rhyodacites makes it convenient to distinguish them by calling them dacites.

3. In most rocks the groundmass is mainly quartz and potash feldspar. The dacite and quartz andesite in unit Smg, however, contains appreciable plagioclase in the groundmass.

THIN-SECTION DESCRIPTIONS

Thin section descriptions of representative rock types are included. The rock types described are listed in the following table, together with the thin section numbers and the Stromlo co-ordinates (in feet) of the locations from which the rock samples were collected.

Thin section number	Rock type	1:2400 sheet no.	Sample location in Stromlo co-ordinates	
69360086+	Rhyodacitic tuff (Suu)	G4A	E2100	N37580
66360039*	Quartz toscanite tuff (Suu)	G4A	E500	N39600
69360081+	Porphyritic rhyolite (Sud_3)	G3C	E1060	N41340
69360080+	Porphyritic rhyodacite (Suw)	G3C	E2330	N43700
69360114+	Rhyolite crystal tuff (Sud_2)	G4A	E6900	N36100
69360084+	Dacitic air-fall tuff (Suw)	G4A	E6030	N39370
67360026*	Banded tuff (Sud_1)	G4B	E7200	N36100
67360027*	Tuffaceous siltstone (Sud_1)	G4B	E7100	N36100
69360087+	Porphyritic rhyodacite (Suu)	G4B	E8440	N38460
66365020*	Welded devitrified rhyodacite (Suu)	G4B	E12000	N35400
67360033*	Quartz siltstone (Sdy)	G4B	E13000	N35600
69360117+	Altered rhyodacite (Smg)	G4B	E12900	N39100
69360116+	Rhyodacite (Smp_2)	H4A	E14300	N37200
67360035*	Adamellite (amg)	H4A	E15500	N35500
72360037**	Dacite or rhyodacite (Smp_1)	H3C	E17500	N42800

*Thin section petrography after C.E. May, Bureau of Mineral Resources

+Thin section petrography after Australian Mineral Development Laboratories

**Thin section petrography by G.A.M. Henderson

Sample 69360086

Rock name:

Welded rhyodacitic lithic-crystal tuff

Hand specimen:

A massive dark-grey to black crystalline igneous rock composed of crystals of feldspar and quartz with ferromagnesian minerals in a fine-grained groundmass.

Thin section:

An optical estimate of the constituents gives the following:

	%
Phenocrysts:	
Quartz	10
Plagioclase	10
Altered ferromganesian minerals	10
Rock fragments	5
Groundmass	65

The rock is composed of fragments and crystals of quartz and feldspar with a few ferromagnesian mineral crystals in a fine-grained groundmass which in places displays a poorly developed eutaxitic texture.

The quartz crystals are similar to those found in other rocks of this suite. They form sharply angular to splinter-shaped fragments which display a uniform extinction and may be traversed by a series of fine fractures along which sericitic micas have crystallized.

The plagioclase crystals are also fragmental with sharply angular outlines, often with ragged edges. The crystals are broken portions of formerly euhedral crystals. Many display a complex oscillatory zoning and have the composition of oligoclase. Many crystals are quite fresh although traversed by a series of fine fractures along which sericitic micas have crystallized. A few crystals are extensively or wholly altered to sericitic micas.

Two types of altered ferromagnesian minerals occur in the sample. One is similar to others found in this suite and forms prismatic or tabular laths composed of chlorite, opaques, muscovite, and sphene. Others have a less regular habit and are formed of chlorite, carbonate, and opaques. Carbonate collects along what appear to be parting fractures in the primary mineral, and the chlorite occupies the available interstitial positions.

A few rock fragments of andesitic/dacitic composition have a random distribution. These are medium-grained and composed of plagioclase (andesine), opaques, and altered ferromagnesian minerals now composed of sericite, muscovite, chlorite and sphene. The fragments may or may not contain essential quartz.

The groundmass is quite heterogeneous. In places it is massive and composed of an aggregate of quartz, and potash feldspar through which are disseminated opaque minerals and carbonate. In other places a poorly developed eutaxitic texture is displayed. This texture resembles that observed in samples 69360079 and 69360085. The texture is formed of numerous sub-parallel streaks of differing colour and composition. The streaks are compressed and moulded about the crystalline components of the rock. In some an axiolotic structure of quartz and potash feldspar is developed. Dusty opaques serve to accentuate the streaks.

Crystals of zircon and opaques complete the assemblage.

Discussion:

This rock is interpreted to have crystallized from a pyroclastic deposit because the specimen shows:

1. Poor sorting;
2. heterogeneous structure;
3. shattered and broken phenocrysts;
4. eutaxitic textures and axiolitic structures;
5. presence of rock fragments.

After deposition and consolidation the groundmass and the ferro-magnesian minerals recrystallized.

Sample 66360039

Rock name:

Metamorphosed devitrified quartz toscanite welded ash-flow tuff

Thin section:

An optical estimate of the constituents gives the following:

	%
Phenocrysts:	
Quartz	10-15
Plagioclase	20-25
Ferromagnesians	10
Groundmass:	55-60

The quartz phenocrysts are rounded and resorbed and the grains are cracked.

The plagioclase is labradorite (An50-60). Grains are zoned and heavily altered to chlorite and sericite. Twinning is distinct to absent.

The ferromagnesian phenocrysts are totally altered to epidote and chlorite.

The groundmass consists of devitrified quartz and potash feldspar, haematite, and chlorite.

Some phenocrysts show glomeroporphyritic structure with clusters of plagioclase, opaques, and chlorite. Other individual grains have selvedges of fine-grained material. The chlorite fills small vesicles and grows as coarse radiating aggregates. Hematite is concentrated in coarsely crystalline patches which have the shape of shards. Staining for potash feldspar revealed a distinct parallel lineation and outlines of former shards, showing that they are only moderately deformed.

Sample 69360081

Rock name:

Massive porphyritic rhyolite

Hand specimen:

A massive, pale pinkish-grey, crystalline igneous rock composed of crystals of quartz and feldspar in a very fine-grained groundmass.

Thin section:

An optical estimate of the constituents gives the following:

	%
Phenocrysts:	
Quartz	30
Potash feldspar	10
Altered ferromagnesian minerals	5
Groundmass	55

The rock is composed of deformed phenocrysts of quartz and altered phenocrysts of feldspar and ferromagnesian minerals in a fine-grained, partially silicified groundmass. The rock lacks a structure on both a macroscale and a microscale. The quartz crystals are irregular to subrounded, and have a size distribution in the range 10 to 0.4 mm. Some show evidence of embayment although this feature is not as pronounced as in the earlier described samples. Many of the quartz crystals have been extensively deformed. They are now composed of a mosaic of sharply angular chips and splintered fragments bound together by late-stage quartz or by elements of the groundmass. In areas of deformation the quartz has a uniform extinction, whereas in the undeformed grains the extinction is somewhat undulose. Undeformed grains are traversed by a network of fine fractures.

The feldspar phenocrysts are potash-rich and two have been appreciably deformed and altered. The crystals are traversed by a network of fractures along which sericite and chlorite have crystallized.

Altered ferromagnesian minerals have a random distribution. Some have a tabular habit and a pronounced cleavage, and are composed of a finely fibrous clay mineral (kaolin?) speckled with disseminated opaque minerals, leucoxene, and sphene. Other ferromagnesian minerals are quite irregular, and rounded to subrounded; they are composed of fibrous and platy clay minerals (kaolin?), lesser amounts of chlorite, and may be stained with hydrated iron oxides.

The groundmass is composed of a massive microcrystalline mosaic of potash feldspar which is slightly discoloured by disseminated hematite?. Small chips of quartz and flakes of clay minerals and chlorite are found throughout the groundmass. Much of which is ironstained - probably as a result of chemical weathering - and in places goethite has formed. The groundmass is traversed by a network of fine fractures along which quartz has crystallized. In some parts of the rock the quartz has penetrated and replaced the potash feldspar of the groundmass.

Crystals of sphene and zircon are ubiquitous accessory components.

Discussion:

The magma from which this rock was derived began to crystallize at depth. Quartz, feldspar, and ferromagnesian minerals crystallized at this time. The partially crystalline magma then suffered a drop in water-vapour pressure, probably consequent upon its emplacement on or near the surface of the crust. During emplacement the crystalline components of the rock were extensively deformed and brecciated. The groundmass gives no indication of whether or not the rock is puroclastic or has crystallized from a fluid magma. However, after the rapid cooling of the groundmass, the rock was mildly deformed, and late-stage silica-rich fluids penetrated the cracks and replaced part of the groundmass. Field relations are required to determine whether the rock is:

1. pyroclastic;
2. lava flow;
3. intrusive.

The habit of the platy ferromagnesian minerals suggests they were formerly biotite.

Sample 69360080

Rock name:

Porphyritic rhyodacite

Hand specimen:

A massive dark-grey crystalline igneous rock. The sample is composed of crystals of quartz, feldspar, and ferromagnesian minerals in an aphanitic groundmass.

Thin section:

An optical estimate of the constituents gives the following:

	%
Crystals fragments:	
Quartz	30
Plagioclase	20
Biotite	2
Altered ferromagnesian minerals	8
Opaques	Acc.
Siliceous groundmass	40

The rock is composed of numerous phenocrysts of quartz, feldspar, and a few ferromagnesian crystals in a massive microcrystalline groundmass.

The quartz crystals and fragments are the most conspicuous components of the sample. They have a size distribution in the range 0.8 to 6 mm, and most have a rounded to deeply embayed habit, although a few are splintered and sharply angular. The crystals have a slightly strained extinction, and many are traversed by trains of minute inclusions and some with incipient fractures. In some places a pale green chlorite has crystallized along the fractures.

The plagioclase crystals have a composition which ranges from calcic oligoclase (about An_{30}) to albite (about An_8). Many of the crystals display a complex zonation in the core regions of the crystals, and towards the margins a progressively more sodic oscillatory zonation. Some of the crystals are quite fresh and undeformed, but others are extensively deformed and broken. These latter crystals are traversed by a network of fractures along which the exsolution of potash feldspar has occurred, and dusty opaques and chlorite have crystallized. In ruptured crystals, the groundmass components have crystallized along the resulting fractures.

Three types of ferromagnesian minerals are distributed throughout the rock. Platy laths of a deep brown pleochroic biotite have a sporadic distribution. Some laths are raggedly terminated, while others are completely euhedral. Some of the crystals show the development of a blue-green chlorite around their margins. Another ferromagnesian component is laths composed of a blue-green anomalous chlorite and pale green pleochroic epidote. The chlorite and epidote have pseudomorphed a primary mineral phase (biotite?), and the epidote has crystallized along former cleavage traces of the primary mineral phase. The third ferromagnesian component is irregular crystals of a bright yellow-green to pale green chlorite. This mineral has also replacing an unknown primary mineral phase.

The groundmass is composed of a finely microcrystalline-granular mosaic of quartz and potash feldspar. Rimming the felsic crystal components of the rock is a fine veneer of either quartz or potash feldspar which has nucleated from the surrounding groundmass. The quartz crystallizes in optical continuity about the quartz crystals, and the potash feldspar about the plagioclase crystals. The remainder of the groundmass is composed of a completely massive mosaic of quartz and potash feldspar.

Chlorite, disseminated opaques, and a few crystals of zircon and apatite complete the assemblage.

Discussion:

This rock may have had a similar petrogenesis to that of 69380079 (Plate 1). Significant differences between this rock and 69380079 include:

1. Presence of fresh biotite crystals in 69380080.
2. Absence of potash feldspar crystal fragments in 69380080.
3. Complex zonation of the plagioclase in 69380080.
4. Absence of a microstructure in the groundmass of 69380080.

The crystalline components of 69380080 have had a similar history to those of 69380079. However, whereas the distinctive groundmass texture of 69380079 allows an interpretation of the genesis of that rock, the absence of any distinctive features in the groundmass of 69380080 does not.

This rock might have been formed as a pyroclastic with complete reconstitution of the groundmass after emplacement such that primary textural features have been destroyed, or it might have been emplaced as a lava flow or very shallow intrusive. Field relations are required to adequately postulate a petrogenesis for this sample. In the absence of distinctive textural features the rock has been described as a rhyodacite suggesting its crystallization from an igneous melt.

Sample 69360114

Rock name:

Rhyolite crystal tuff

Hand specimen:

Pale medium-grained rock with phenocrysts of quartz and pink and white feldspar.

Thin section:

An optical estimate of the constituents gives the following:

	%
Phenocrysts:	
Quartz	20-25
Sanidine	20-25
Plagioclase	5-10
Volcanic rock fragment	
Altered biotite?	Trace
Groundmass rich in potash feldspar	40-50

The rock contains crystals and angular chips of quartz and feldspar and a few crumpled flakes of altered mica abundantly scattered through a 'groundmass' which varies from cryptocrystalline to microcrystalline and contains very numerous altered or devitrified shards. Parts of the groundmass contain small globular to oval textures through a fine-grained mosaic of quartz and feldspar.

There are some distinct fragments of porphyritic volcanic rock with coarser grained groundmass.

Staining with cobaltinitrite indicates abundant potash feldspar in the groundmass.

Plagioclase phenocrysts have been partly replaced by sericite, and traces of sericite also occur along numerous very thin shear planes through the rock.

History:

Crystals and angular fragments of quartz and sanidine, with a few plagioclase crystals, traces of biotite, and volcanic rock fragments are surrounded by a 'groundmass' originally composed largely of glass shards and fragments.

Sample 69360084

Rock name:

Dacitic air-fall crystal tuff

Hand specimen:

A dark medium-grained greenish grey crystalline igneous rock. The sample is composed of crystals of quartz, feldspar, and mafic minerals in a fine-grained groundmass. The rock has an incipiently banded structure defined by variations in the fragment to groundmass ratio.

Thin section:

An optical estimate of the constituents gives the following:

	%
Crystal fragments:	
Plagioclase	40
Quartz	10
Altered ferromagnesian minerals	5
Sphene	Acc.
Rock fragments	15
Groundmass	30

The rock is composed of a closely compacted aggregate of plagioclase, quartz crystal fragments, and a few rock fragments in a very fine-grained siliceous groundmass. The plagioclase crystal fragments have a wide size distribution in the range 0.8 to 5 mm and have a completely irregular shape. All are sharply angular to subrounded fragments of formerly euhedral crystals. The plagioclase has the composition of calcic oligoclase, and the crystals are magmatically reddened by finely disseminated hematite? Some crystals show the development of incipient alteration to fine-grained colourless clay minerals and to pale green chlorite.

Quartz fragments are much less abundant than the feldspar fragments and are very much finer-grained. They have a fragmental habit and display an undulose extinction.

Altered ferromagnesian minerals are quite common. These are now wholly composed of anomalous green chlorite and minor opaques which form along former cleavage traces of the primary mineral phase. The crystals usually show little evidence of fragmentation and have a tabular or platy habit. The crystals are aligned in the plane of the banding observed in hand specimen.

Rock fragments are randomly distributed, are angular to subangular in shape, and have a similar size distribution to that of the plagioclase crystals. The majority of the fragments are composed of a microcrystalline quartz mosaic through which is scattered disseminated chlorite. These fragments are non-genetically best described as chert. A few fragments are composedof a completely colourless mosaic of albite crystals which may be associated with minor opaques (concentrated along crystal boundaries) and carbonate (which, when present, occupies the core regions). A third rock fragment type, only one fragment of which was noted, is composed of an aggregate of colourless albite crystals and laths of ironstained chlorite.

Much of the groundmass of the rock is composed of a massive microcrystalline to cryptocrystalline mosaic of quartz through which are disseminated fine-grained clay minerals and chlorite. In those layers of the rock which have a high fragment to groundmass ratio very fine-grained fragments of quartz and feldspar are abundant. A few crystals of apatite and opaques form the accessory components of the rock.

A series of fine fractures traverse the rock and parallel the poorly defined banding. The fractures - along which there appears to be no displacement - traverse both the groundmass and the crystal fragments; they are infilled with colourless microcrystalline quartz, a which has penetrated and replaced portions of the groundmass.

Discussion:

The high fragment-to-groundmass ratio and the heterogeneous nature of the rock indicates that it has formed by the accumulation of explosively brecciated crystalline igneous rocks. The rock is comparatively well sorted, and the groundmass shows evidence of having crystallized from an ash. Thus it is interpreted that the rock represents an ash-fall crystal tuff.

In post-consolidation times the rock has been subjected to minor deformation and late-stage silicification. A feature of this sample, in contrast to the remainder of the suite, is the complete absence of potash feldspar.

Sample 67360026

Rock name:

Banded tuff

Hand specimen:

The rock is weathered to a purplish colour with scattered white grains and dark elongate blebs of mica which delineate the laminae.

Thin section:

The rock consists of phenoclasts of quartz (7-10%), feldspar (2-3%), and altered ferromagnesian minerals (2-3%) widely scattered through a fine-grained matrix of partly devitrified glassy ash. The rock is poorly sorted; phenoclasts range in size from 0.3 to 1 mm and the matrix has an average grainsize of less than 0.002 mm.

The grains are angular, rarely euhedral, and commonly altered by the encroaching matrix. The feldspar grains are mostly altered to chlorite, and contain tiny grains of opaque material. The ferromagnesian minerals are totally pseudomorphed by chlorite, muscovite, and opaque minerals. By their outline and relict cleavage some grains were clearly originally phyllosillicates. Some other grains have a recognizable amphibole outline. These pseudomorphs with slight variation are common throughout the volcanics of the Belconnen district.

The matrix shows small trails of opaque grains and rough parallelism amongst the mica flakes; apart from this it is structureless. Alteration of the glassy material to chlorite and prehnite has taken place in some parts of the matrix causing large areas to have the same optical orientation.

The rock is a sedimentary tuff.

Sample 67360027

Rock name:

Tuffaceous siltstone

Hand specimen:

In hand specimen the rock appears to be composed of siltsized grains with bands of finer and coarser material. It is light brown with bands of black. Joint surfaces are stained with iron oxides.

Thin section:

Under the microscope the fine and coarse laminae have different textures and composition. The coarse laminae are moderately sorted and consist of narrow elongate chips of quartz (30%), which lie parallel to the bedding laminae, in a matrix of phyllosilicates (70%). Many of the larger flakes in the matrix are biotite which is slightly to very leached to sericite; in many places it is moulded against quartz grains. There are a few grains of accessory tourmaline. The composition of the fine laminae is the same as the matrix of the coarse laminae; some finely divided quartz may be present. Current-bedding is visible in the finer laminae.

This rock appears to consist, at least in part, of volcanic detritus and the current-bedding indicates that it was deposited in water.

Sample 69360087

Rock name:

Massive porphyritic rhyodacite

Hand specimen:

A crystalline weakly banded dark grey rock which in places is tinted in shades of red and green. The rock is composed of phenocrysts of quartz and feldspar set in a fine-grained groundmass.

Thin section:

An optical estimate of the constituents gives the following:

	%
Phenocrysts	
Quartz	5
Plagioclase	15
Altered mafic minerals	7
Rock fragments	5
Groundmass	68

The rock is composed of numerous phenocrysts of quartz, plagioclase feldspar and altered mafic minerals in a fine-grained groundmass. There is no evidence to suggest that the quartz phenocrysts are splintered relicts of formerly whole crystals. In this rock the quartz has an irregular habit and is formed of well rounded crystals, the margins of which are deeply embayed. Many of the crystals are traversed by a network of fine fractures which do not extend into the groundmass, but along which colourless clay minerals have crystallized. The crystals have a uniform extinction and are clear, although in some there are minor disseminated inclusions.

The plagioclase crystals have an irregular and broken habit, are poorly twinned, and show no evidence of chemical zonation. The fragmental crystals were formerly portios of euhedral crystals. The feldspar is calcic oligoclase and shows appreciable alteration to fine-grained sericitic micas.

The altered ferromagnesian minerals in this rock resemble those in the other samples described. Two types are present: the most common are subangular to subrounded masses of colourless sericitic micas and chlorite, which may be associated with opaque minerals; the other ferromagnesian mineral displays a prominent relict cleavage defined by concentration of secondary iron oxides. The remainder of these crystals are composed of sericite/muscovite and minor chlorite.

Rock fragments are conspicuous. They are subrounded to subangular, and are composed of a subradiating aggregate of plagioclase crystals in a groundmass composed of sericite, colourless clay minerals, and opaques. A few fragments contain phenocrysts of plagioclase. Both the phenocryst and the groundmass plagioclase is andesine partly replaced by disseminated clay minerals. Accessory zircon crystals are present in some fragments. The xenoliths are altered medium to fine andesites.

The groundmass of the rock is largely composed of a mass of discoloured microcrystalline potash feldspar through which are distributed splinters of crystal fragments and their alteration products. The bulk of the groundmass is very fine-grained, but is traversed by a poorly developed network of curvilinear cracks along which more coarsely crystalline potash feldspar has formed. A yellowish green chlorite, disseminated opaques, epidote, and sphene also tend to be confined to these zones. Crystal chips, splinters, and fragments distributed throughout the groundmass include quartz, feldspar, and altered mafics. Apatite and zircon are the accessory components.

The weak banding observed in hand specimen is in part developed by subtle variations in the degree of crystallinity of the groundmass, and in part by the relative concentration of disseminated opaques. Parts of the groundmass are traversed by a series of fine discontinuous fractures along which secondary iron oxides and opaques have crystallized.

Discussion:

There is little direct petrographic evidence in this rock to indicate whether it crystallized from a fluid magma or from a pyroclastic deposit.

The embayed and rounded quartz phenocrysts are products of early crystallization, and have been modified by resorption, probably attendant upon a drop in water-vapour pressure. The broken and splintered feldspar crystals and the presence of rock fragments do not necessarily indicate a pyroclastic rock. The phenocrysts might have been broken during flowage and the fragments incorporated from an earlier formed rock.

The curvilinear cracks in the groundmass suggest perlitic cracks developed in a glass by contraction during cooling. The glass might indicate that the rock is part of a lava flow, or it might be the result of extreme welding of a pyroclastic deposit. The groundmass has recrystallized obliterating any relict primary textures which may have been used to elucidate the history of this rock.

These comments apply to several of the examined rocks, and underline the importance of field relations for deciphering the origin of fine-grained igneous rocks.

<u>Sample 66365020</u>

Rock name:

Welded devitrified rhyodacite.

Thin section:

An optical estimate of the constituents gives the following:

	%
Phenocrysts:	
Quartz	25-30
Altered plagioclase	15-20
Zircon and rutile	Trace
Groundmass	55-60

The quartz phenocrysts occur as clusters of broken grains showing undulose and polysectional inclusions. The grains contain many inclusions and overgrowths are common.

The plagioclase phenocrysts are of composition An10-20 and are altered to sericite and chlorite. Twinning is patchy, and the grains are broken and disoriented.

The groundmass is quartz and plagioclase intergrown in a saccharoidal texture. There are streaks of chlorite, stains of opaque minerals, and larger angular fragments of quartz and feldspar. The groundmass has resulted from the devitrification of glass.

Sample 67360033

Rock name:

Quartz siltstone

Hand specimen:

This rock is greenish grey, very fine-grained, and massive, with ironstained slickensided joints. There are rare blebs of secondary silica. The rock does not contain detectable carbonate.

Thin section:

The rock appears to be bedded with coarse and fine laminae. The coarse laminae are lenticular and disturbed by micro-slumping. The fine laminae consist of chlorite, leached biotite and some small angular quartz grains. The coarse laminae are similar to the fine laminae, but the phyllosilicates show better crystal forms, and some plagioclase grains are present. The rock is veined with secondary silica, and some veins contain plagioclase, indicating that the rock has been slightly metamorphosed. Rare clay pellets have been altered to chlorite, and some contain grains of quartz or plagioclase. Some pellets have been silicified.

Sample 69360117

Rock name:

Altered rhyodacite

Hand specimen:

Very fine-grained grey rock with sparse phenocrysts.

Thin section:

An optical estimate of the constituents gives the following:

	%
Phenocrysts:	
Quartz	5-10
Altered plagioclase	15-20
Altered potash felspar	3-5
Opaque grains (leucoxene)	1-2
Groundmass:	
Plagioclase	20-30
Potash feldspar (stained)	15-20
Quartz	Trace
Chlorite (varies)	3-5
Zircon	Minute Trace
Secondary epidote	3-5
Secondary carbonate	5-10
Rock fragments	Trace

A few rounded and embayed quartz phenocrysts and extensively altered feldspar crystals are scattered through a groundmass composed mainly of plagioclase and potash feldspar. The feldspar phenocrysts are of various sizes and a few of the plagioclase phenocrysts are clumped together into irregular aggregates. Some are zoned, and all are extensively altered.

The groundmass varies in grainsize and texture. Some of it contains fine-grained prismatic plagioclase, but much of it is now composed of a mosaic of feldspar grains which have probably recrystallized after the rock consolidated. They form a cloudy patchy mosaic intergrown with chlorite. Irregular patches of medium-grained epidote have replaced parts of the groundmass and some feldspar phenocrysts. Calcite is associated with much of the epidote and also replaces feldspar grains.

Some crystals and patches of the groundmass have been replaced by chlorite. One 4-5 mm rock fragment included in the section is finer-grained than the host rock, does not contain phenocrysts, and is composed mainly of prismatic plagioclase with interstitial chlorite and sphene and a few small patches of secondary epidote. It is probably a fragment of basic volcanic rock.

The groundmass is mainly of uniform, fine-grained potash feldspar with traces of quartz and iron oxide and with a texture typical of devitrified volcanic glass.

History:

Volcanic rock of acid composition. This is not a pyroclastic.

Sample 69360116

Rock name:

Rhyodacite - possibly a tuff

Hand specimen:

Massive and uniform fine-grained dark greenish grey rock with phenocrysts.

Thin section:

An optical estimate of the constituents gives the following:

	%
Phenocrysts:	
Quartz	20-25
Plagioclase (some near Ab50)	20-25
Altered mica	10-15
Chlorite patches	3-5
Cryptocrystalline groundmass with K-feldspar	30-35
Accessory:	
Apatite	Trace
Zircon	Trace
Xenocryst - garnet	Minute trace
Secondary sericite	1-2
Secondary carbonate	Trace
Secondary epidote	Minute trace
Secondary sphene	Trace

The rock contains numerous angular fragments and embayed crystals of quartz (0.2 - 0.6 mm), subhedral to irregular crystals and fragments of plagioclase, flakes of former biotite now replaced by chlorite, sphene, minor epidote, and a few angular irregular patches of almost isotropic chlorite in a cryptocrystalline groundmass which is extensively stained by cobaltinitrite suggesting appreciable potash feldspar.

Altered biotite flakes are generally parallel to a definite lineation or flow direction. Some are crumpled or bent and a few contain inclusions of apatite or zircon. A few plagioclase grains are fractured or shattered and some are surrounded by chlorite patches. Many are fresh, and twinning is clearly preserved. Some are more calcic than in other rocks.

The section includes part of an altered rock fragment now composed of secondary plagioclase (albite?), radiating and irregular aggregates of epidote minerals of varying composition, grains replaced by prehnite?, and one angular and fractured grain of garnet. This rock type contains more abundant opaque grains partly replaced by leucoxene, and also contains embayed crystals os plagioclase and patches of chlorite.

The direction of lineation in the fragment is at an angle to that in the host rock.

History:

Volcanic rock containing phenocrysts of rather different composition to that of the groundmass. There is a weak lineation or flow structure and the rock contains very few altered volcanic rock fragments. It is possibly of pyroclastic origin, but definite evidence to confirm this is lacking and may have been obliterated by welding.

Sample 67360035

Rock name:

Adamellite

Hand specimen:

The rock is pale pink, and contains large phenocrysts of clear quartz, potash feldspar, pale green plagioclase, and large irregular ferromagnesian grains in a fine-grained groundmass. There is no visible foliation.

Thin section:

An optical estimate of the constituents give the following:

	%
Quartz	35-40
Plagioclase	25-30
K-feldspar	30-35
Ferromagnesians	5-10

The quartz phenocrysts are fresh, and generally have straight extinction; some contain trails of bubbles. The plagioclase is extensively altered and consists of tiny crystals of epidote, muscovite, and quartz. The potash feldspar grains are clouded by vacuoles and show slight alteration to kaolinite. The ferromagnesian minerals are altered to chlorite, actinolite, and large crystals of epidote. There are rosettes of muscovite which may be authigenic.

The average grainsize of the groundmass is about 0.08 mm, and consists of equigranular angular grains of quartz, plagioclase, and potash feldspar. The grains do not interlock, but there is no void space. Interstitial grains of actinolite and epidote occur probably as secondary minerals. The groundmass comprises about 60% of the rock.

The porphyritic texture of the rock indicates that it is probably a high-level intrusion. It has the composition of an adamellite.

Sample 72360037

Rock name:

Dacite or Rhyodacite

Hand specimen:

A massive green-grey crystalline igneous rock composed of quartz, prominent white feldspar, and ferromagnesian minerals in a groundmass of indeterminate constituents.

Thin section:

An optical estimate of the constituents gives the following:

	%
Phenocrysts	
Quartz	20
Plagioclase	20
Altered ferromagnesian minerals	10
Calcite	5
Apatite	Trace
Groundmass	45

The rock is composed of crystals and crystal fragments of quartz, plagioclase (An_{52}), and patches of chlorite and minor calcite in a groundmass predominantly of microcrystalline feldspar together with quartz, opaques, and blebs of chlorite.

The quartz crystals are generally rounded and in places embayed. They commonly contain small cracks, some of which are filled with an unidentified mineral of strong birefringence (possibly sericite). The crystals range in size to about 4 mm.

The plagioclase crystals show a similar size range to the quartz. Where not altered to sericite, the plagioclase displays multiple twinning, and a few crystals show oscillatory zoning.

The ferromagnesian minerals are entirely altered from the original mineral. Although some retain the form of the original mineral, it is not evident what the mineral was. Some of the ferromagnesians are aggregates of chlorite, epidote, and opaques, and some consist entirely of chlorite. The chlorite is yellow-green in ordinary light, and under crossed nicols shows an anomalous blue-green or purple birefringence; it is in part composed of spherulitic aggregates. An elongate crystal in one place is entirely altered to another type of chlorite showing first order yellow interference colours and wavy extinction.

The calcite occurs in localized patches with very ragged boundaries.

The groundmass is of uniform texture throughout the slide. Staining with sodium cobaltinitrite indicates a high proportion of potash feldspar.

APPENDIX 3
CHEMICAL ANALYSES OF IGNEOUS ROCKS BY AMDEL, 1975

Rock unit or symbol	Mount Painter Porphyry	Suw	Smg	Smp_1	Sud_2	Suu
Analysis number	75360001	75360008	75360014	75360015	75360017	75360018
Map sheet Co-ordinates	Canberra 1:100 000 N6108500 E678600	Brindabella 1:100 000 N6092300 E688300	G3D N43500 E13000	H3C N42800 E17500	G4A N37800 E6800	G4B N37600 E8300
SiO_2	65.49	68.59	64.07	67.09	75.62	67.54
TiO_2	0.63	0.49	0.56	0.57	0.10	0.57
Al_2O_3	14.11	14.79	13.98	14.17	12.74	13.95
Fe_2O_3	0.95	1.35	1.98	1.17	0.88	3.28
FeO	4.30	2.15	3.05	3.25	0.40	0.90
MnO	0.08	0.06	0.07	0.04	0.04	0.06
MgO	1.49	1.33	3.32	2.32	0.41	1.80
CaO	3.63	3.88	1.79	2.51	1.01	1.75
Na_2O	1.67	2.42	2.69	2.45	2.62	2.00
K_2O	3.57	2.96	3.55	3.41	5.00	4.83
P_2O_5	0.15	0.12	0.13	0.14	0.04	0.14
H_2O^+	2.16	1.40	2.83	2.21	0.81	1.90
H_2O^-	0.10	0.04	0.13	0.05	0.01	0.16
CO_2	0.80	0.05	1.25	0.40	0.10	0.35
TOTAL	99.13	99.63	99.40	99.78	99.77	99.23

APPENDIX 3 (contd.)

Rock unit or symbol		Mount Painter Porphyry	Suw	Smg	Smp_1	Sud_2	Suu
Analysis number		75360001	75360008	75360014	75360015	75360017	75360018
Map sheet Co-ordinates		Canberra 1:100 000 N6108500 E678600	Brindabella 1:100 000 N6092300 E688300	G3D N43500 E13000	H3C N42800 E17500	G4A N37800 E6800	G4B N37600 E8300
Trace elements in ppm	Cu	24	12	6	4	6	16
	Zn	96	51	77	69	38	70
	Co	12	10	10	6	2	12
	Ni	40	10	30	20	6	36
	Cr	95	25	95	65	10	40
	V	110	100	100	100	25	95
	S as % SO_3	0.09	0.18	0.10	0.06	0.05	0.06
	Rb	165	140	150	165	250	240
	Sr	150	210	100	140	90	135
	Ba	640	740	560	560	280	900
	Pb	22	65	10	18	34	20
	Nb	10	10	10	10	10	10
	Ce	100	110	70	90	90	110
	Th	16	14	14	14	10	6
	U	6	4	4	6	24	14
	Y	25	20	25	30	50	35
	Zr	200	200	150	190	85	200
	La	70	60	50	40	50	70

PLATE 1

GEOLOGICAL MAP OF NORTHWEST BELCONNEN

A bar over a symbol $\overline{Sud_2}$ indicates that the rock unit has a cover of residual soil

QUATERNARY			Alluvium
U. SILURIAN?	GLEBE FARM ADAMELLITE	amg	Adamellite - INTRUSIVE
UPPER SILURIAN	WILLOW BRIDGE TUFF	Suw	Rhyodacite
		Suw?	Rhyodacite (INTRUSIVE OR EXTRUSIVE?)
MIDDLE SILURIAN?	UNNAMED PORPHYRY	Smp_2	Dacite
		Smp_1	Dacite
UPPER SILURIAN	DEAKIN VOLCANICS?	Sud_3	Rhyolite, rhyolitic breccia
		Sud_2	Rhyolite
		Sud_1	Tuff, siltstone
	UNNAMED VOLCANICS	Suu	Rhyodacite, tuff, siltstone
	YASS SUB-GROUP	Sdy	Siltstone, limestone
MIDDLE SILURIAN	GLENESK FORMATION	Smg	Dacite, quartz andesite
	WESTMEAD PARK FORMATION?	Smw	Siltstone, shale

A—B Cross section (see Plate 2)

Geological boundary, accurate
Geological boundary, approximate
Geological boundary, inferred
Fault, position accurate (U - upthrow, D - downthrow)
Fault, position approximate
Fault, inferred
Thrust fault
25 Dip and strike of bedding
⊙69/79 Thin section number (abbreviated*)
Area of outcrops or exposure in excavations
Swampy area
Road or street
2100 Topographical contour in feet above M.S.L.

*full number is 69360079

Unconformity
Unconformity (sections only)
Anticline } dashed where inferred
Syncline } dashed where inferred
Fossil locality
Quartz reef
⊗75/14 Chemical analysis number (abbreviated)
○24 Water bore and registered number
Trunk sewer trench

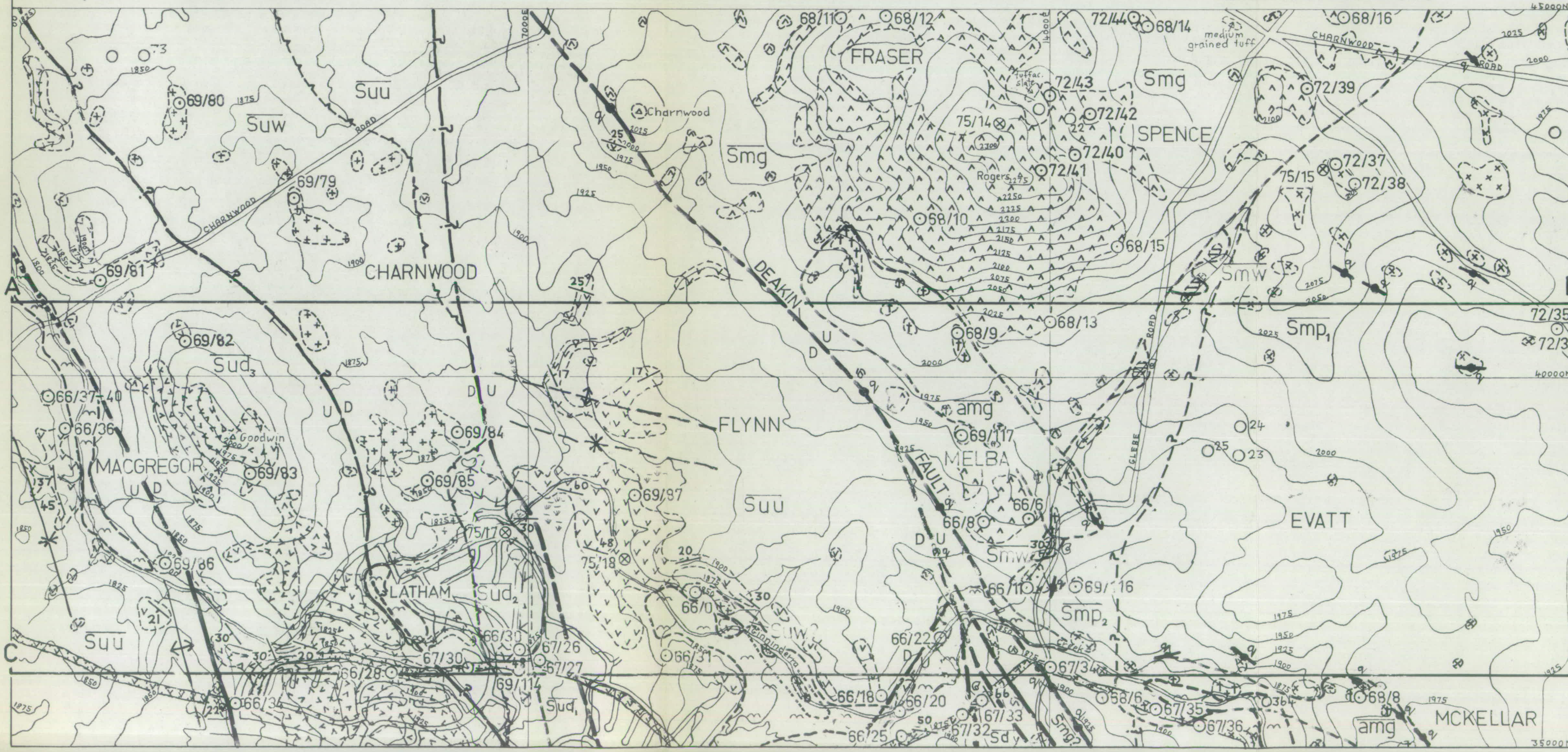
SCALE

0 — 1/4 — 1/2 — 3/4 — 1 Mile

0 — 1/2 — 1 Km.

INDEX TO FIELD SHEETS

G3C	G3D	H3C
G4A	G4B	H4A



AMENDMENTS			
No.	Description	Author	Checked
A1			
A2			
A3			
A4			
A5			

SCALE as above

Base map/survey NCDC plan

Geology by G.A.M. Henderson et al

Compiled and checked G.A.M.H. Project geologist

Checked and approved Senior geologist

Supervising geologist

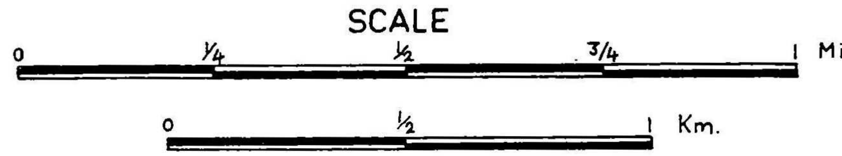
COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.

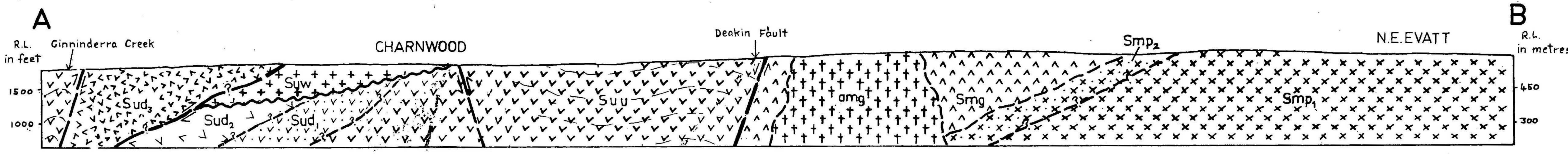
TITLE GEOLOGICAL MAP OF NORTHWEST BELCONNEN

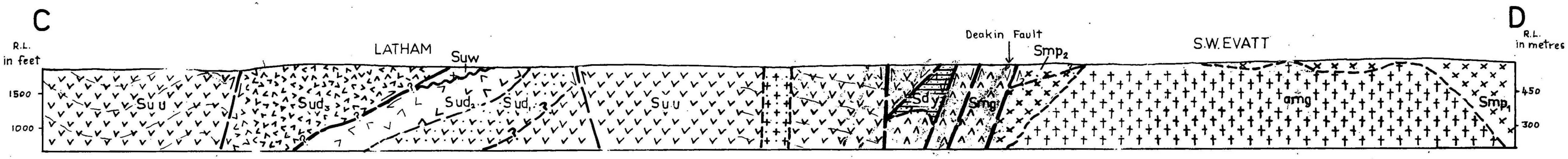
PROJECT GEOLOGY OF BELCONNEN

To accompany Record 1975 113 | Drawn by G.A.M.H. | Drawing No. I55/A16/1385

INTERPRETATIVE CROSS SECTIONS OF NORTHWEST BELCONNEN







For locations of sections and reference see Plate 1

AMENDMENTS			
No	Description	Author	Checked
A1			
A2			
A3			
A4			
A5			

SCALE as above	COMMONWEALTH OF AUSTRALIA BUREAU OF MINERAL RESOURCES CANBERRA, A.C.T.
Base map/survey	TITLE INTERPRETATIVE CROSS SECTIONS OF NORTHWEST BELCONNEN
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